NASA - A Partner in Disaster Risk Reduction for Public Safety

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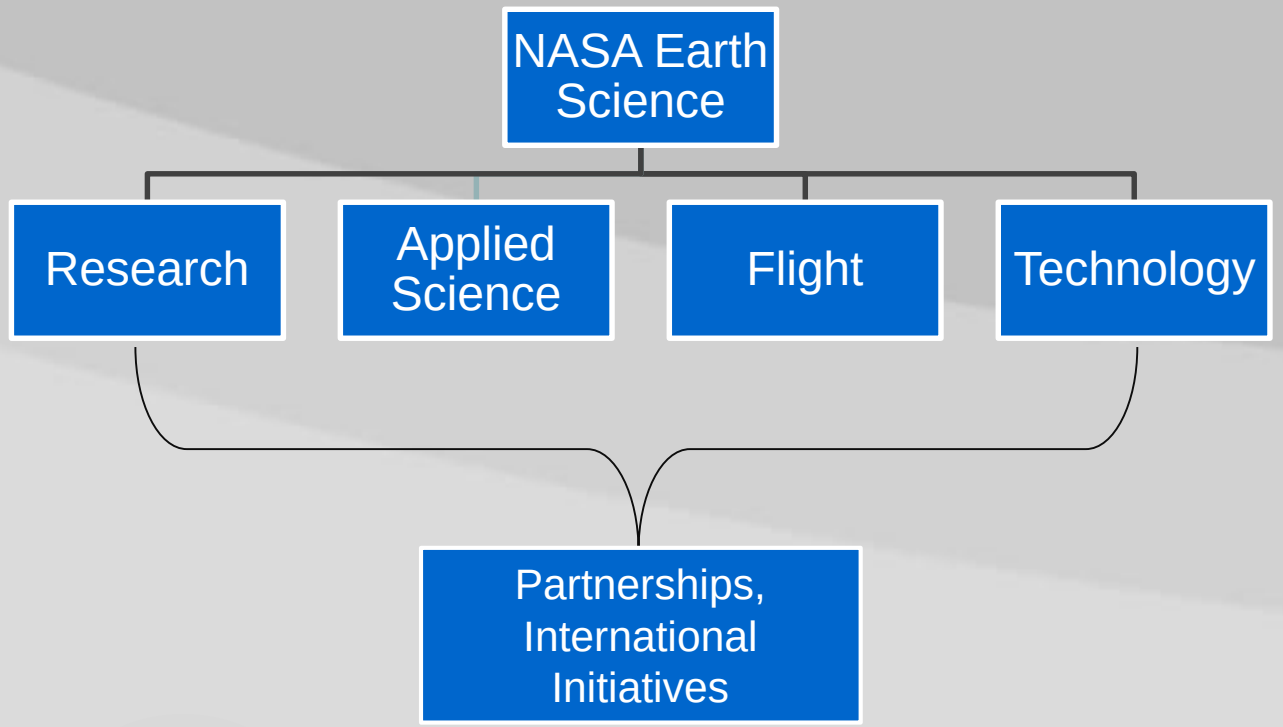
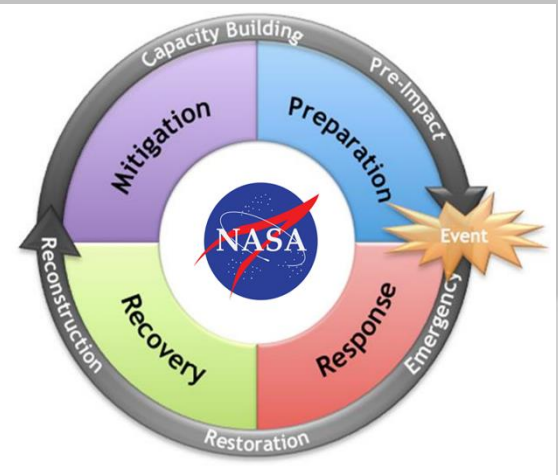
Science Mission Directorate
Earth Science Division

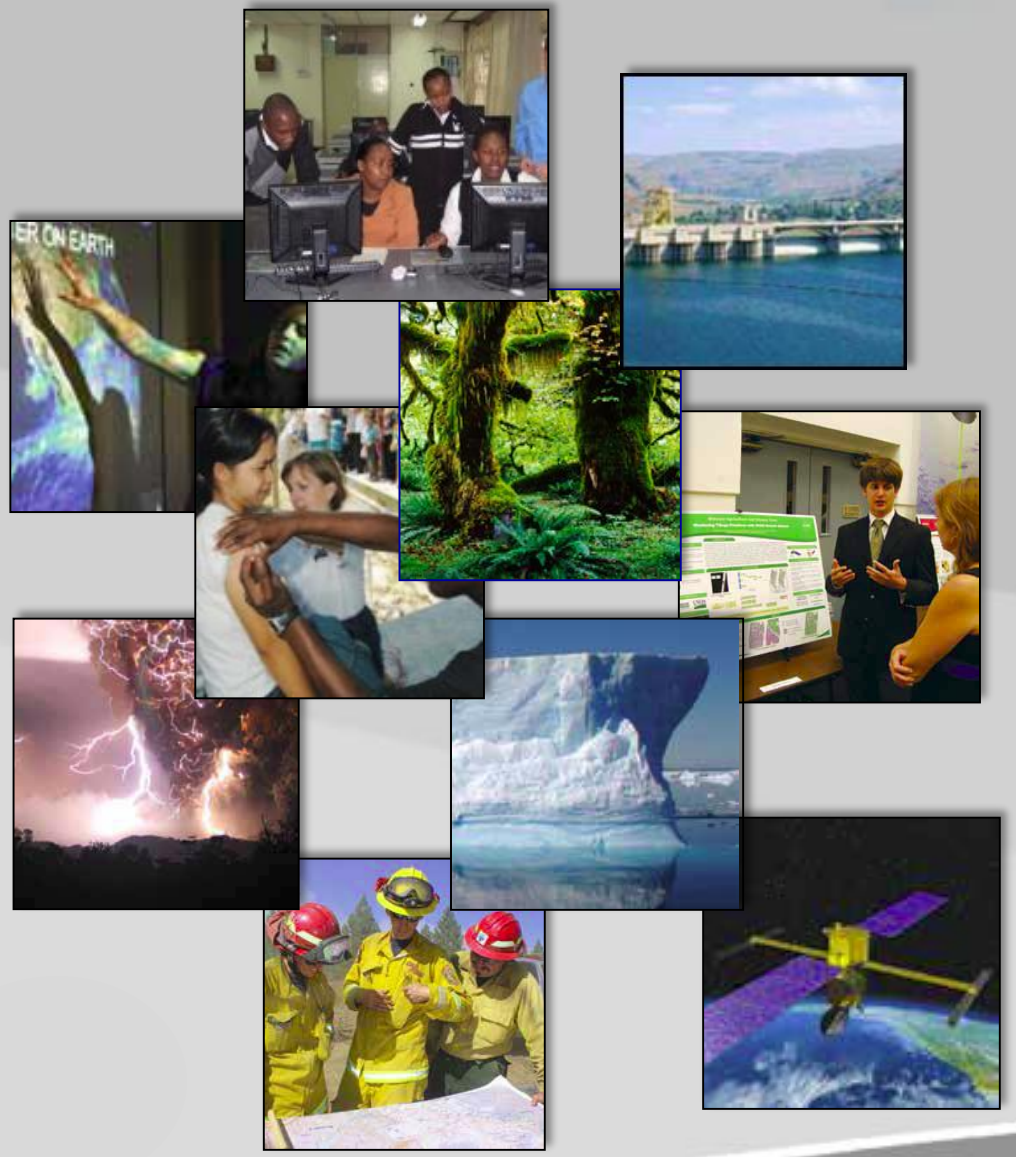


Disaster Response



NASA's Earth Science DISASTERS

Application Themes & Societal Benefit Areas



Programmatic Focus on:

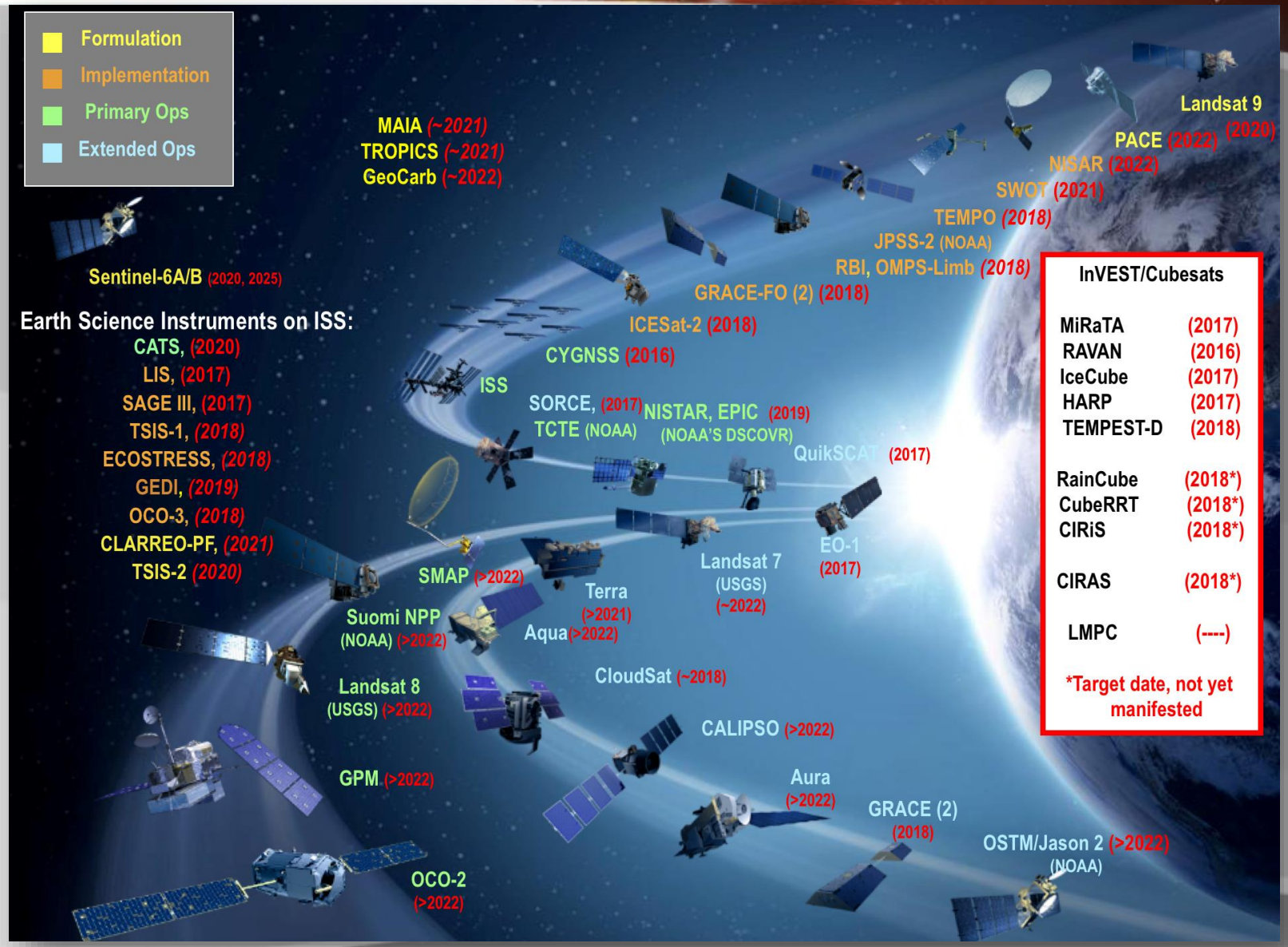
- ↗ Health & Air Quality
- ↗ Disasters
- ↗ Water Resources
- ↗ Wildfires
- ↗ Ecological Forecasting

Support ad hoc opportunities in additional areas:

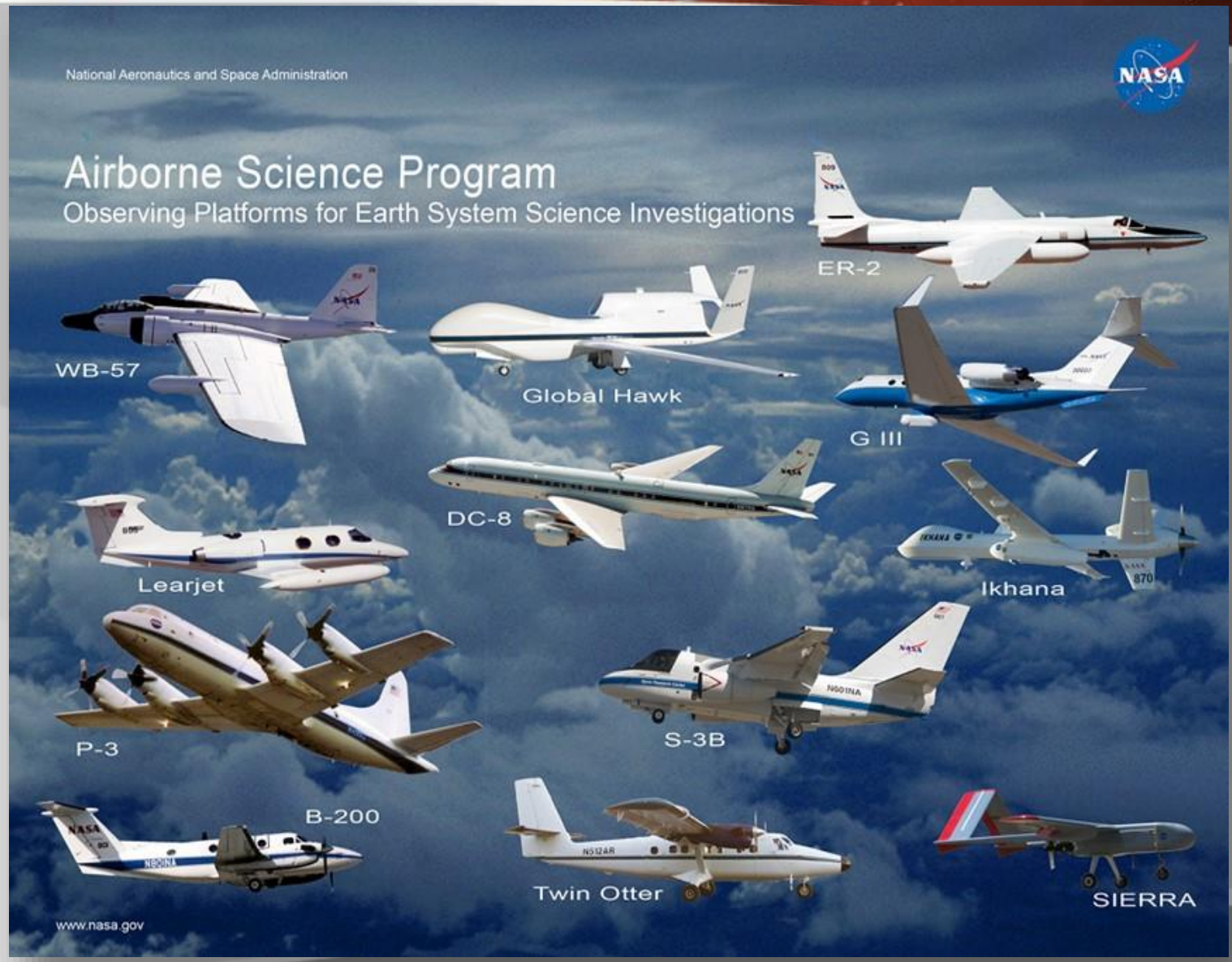
- ↗ Agriculture & Food Security
- ↗ Aviation Safety
- ↗ Climate & Weather
- ↗ Energy
- ↗ Socioeconomic Impacts

Operating NASA Earth Science Missions

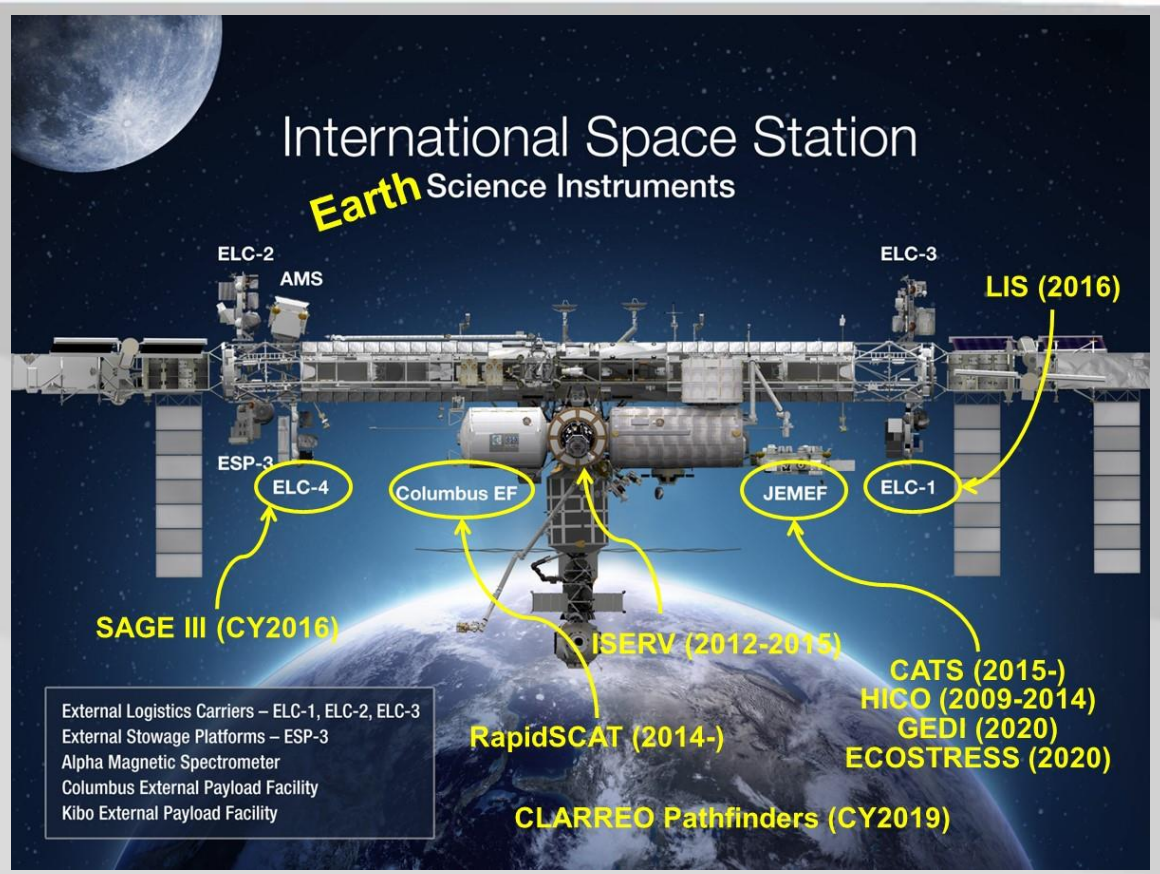
Planned NASA Earth Science Missions



Airborne Observing Platforms



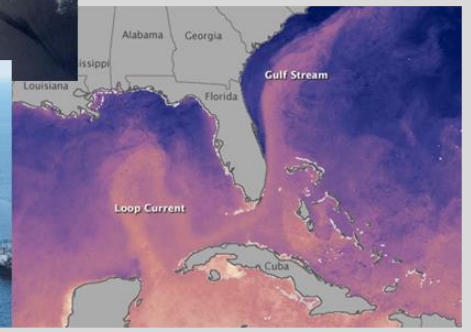
International Space Station Science



NASA provides a unique perspective

NASA Disaster Response Program

- Disasters Applications area promotes the use of Earth observations to improve prediction of, preparation for, response to, and recovery from natural and technological disasters.



Deepwater Horizon Oil Spill , 2010

Earthquakes | Volcanoes | Landslides | Floods | Fires | Land Subsidence

Multi-hazard and Global

NASA Applied Sciences DISASTERS

Disaster Program Rapid Assessment and Response Tiers of Disaster

- Assessment: 50-100 Events/Year
- Tier 1: 10-30 Events/Year
- Tier 2: 3-10 Events/Year
- Tier 3: 0-3 Events/Year

Assessment

Rapid Hazard Assessment Expected

- Centers and program experts to contribute within scope of daily activity
- Guidance to elevate to Tier response, direct to research or no action
- Days

E.g.: media report

Tier 1

Response and Recovery Short Term and Best Effort

- Centers and programs respond as available with only minor impact to existing/on-going activities
- Detailed assessment and products scaled to modest response
- Weeks to Month(s)

E.g..: Napa Earthquake (2014), Chile Earthquake (2015), Oklahoma tornadoes, yearly floods

Tier 2

Significant Contributions Over Extended Period

- Contributions are considerable given continual assessment of size and scale of impact
- Personnel relevant to disaster type (s) expected, tasked, and assigned to support
- Data and products adapted into recovery
- Weeks to Month(s)

E.g.: Nepal Earthquake (2015), Deep Horizon (2010), Eyjafjallajökull Eruption (2015)

Tier 3

Disaster is of major national importance

- All relevant personnel expected to review activities for level of support to the disaster and/or be on-call
- Assets and personnel may specifically assigned and tasked for lengthy time period (Months into recovery).

E.g.: Super Storm Sandy (2012), Hurricane Katrina (2005), September 11, 2001 attacks

NASA Applied Sciences DISASTERS

PUBLIC SAFETY SCENARIOS

CRITICAL INFRASTRUCTURE MONITORING

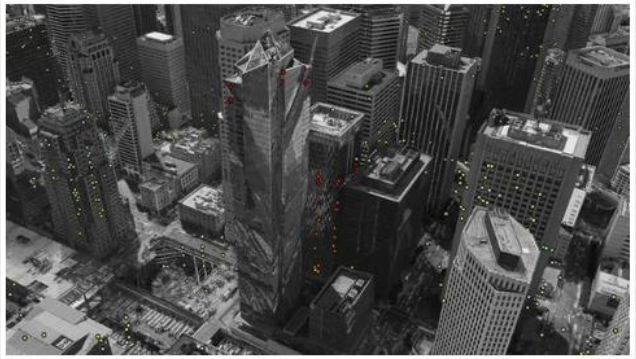
Thanks to: Cathleen Jones, NASA Jet Propulsion Lab

Critical Infrastructure Monitoring

REAL ESTATE

Photo shows San Francisco's Millennium Tower sinking from space

Share G+1 Tweet Email

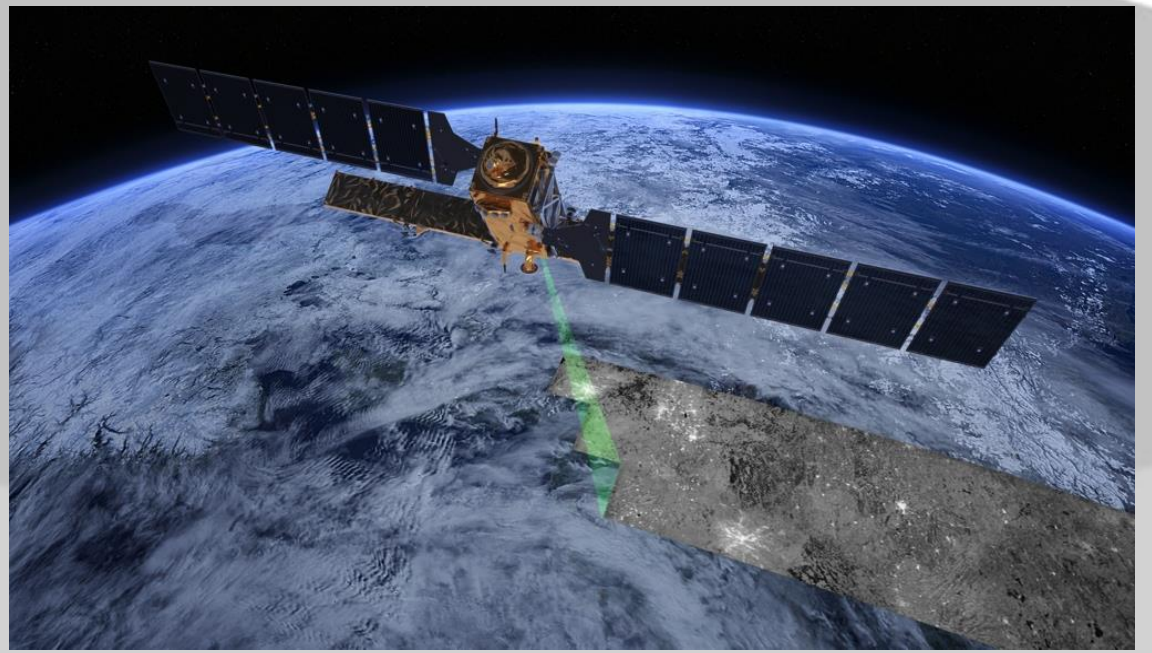


The image provided by the ESA on Thursday, Nov. 24, 2016, shows the Millennium Tower in San Francisco on the base of modified Copernicus Sentinel satellite data. (ESA SEOM INSARAP study/ESA via AP)

Tuesday, November 29, 2016

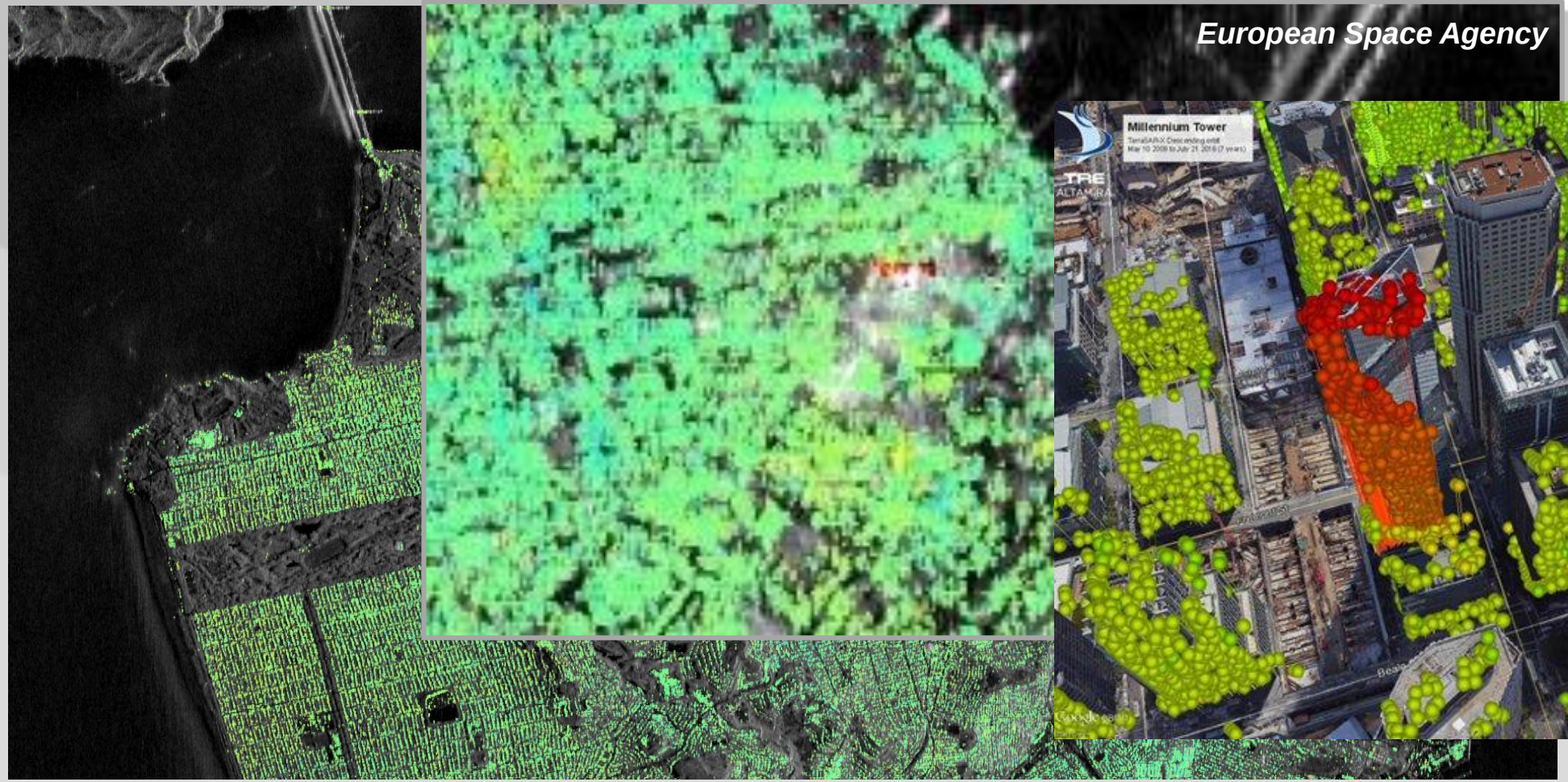
SAN FRANCISCO (KGO) -- The European Space Agency released photos that show San Francisco's Millennium Tower sinking from space.

The 58-story building has sunk 16 inches since it opened in 2009.



Sentinel-1
European Space Agency
Synthetic Aperture Radar

Monitoring a Highrise



European Space Agency

TRE ALTIMIRA

Technique: Processing multiple SAR images collected over time to detect small-scale movement (cm/yr to mm/yr)

Synthetic Aperture Radar

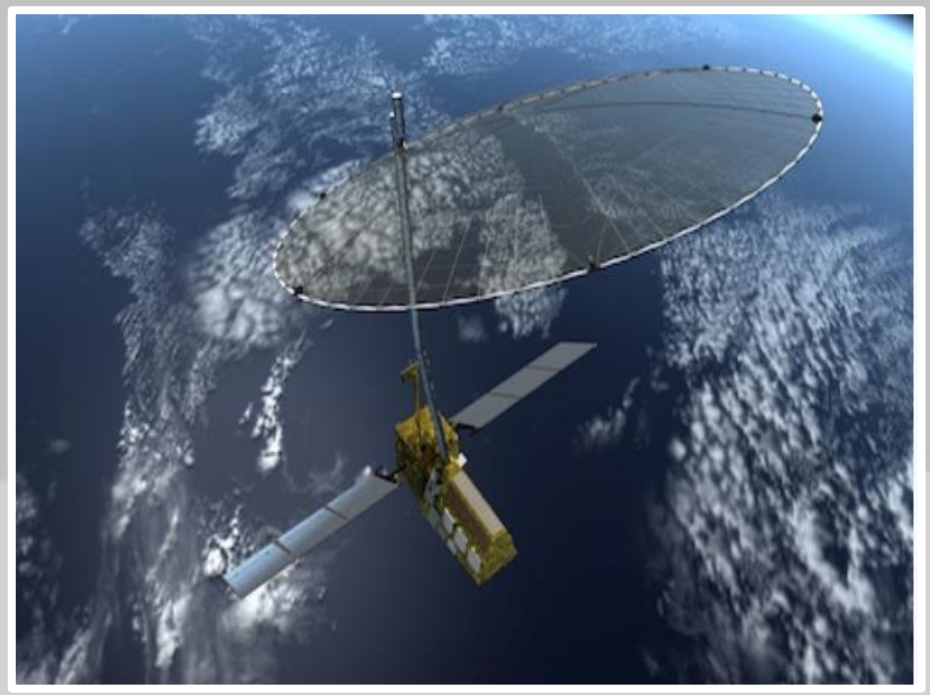
Microwave-band Radar can…

1) See through clouds, smoke, haze.
2) Image day or night, in any light conditions.
3) Rapid, relatively high resolution (~1-10 m), imaging of large areas (10-100s km)
4) Detect standing water.
5) Determine surface type.
6) Identify surface change.
7) Detect very small scale (few millimeters) movement of the ground.

UAVSAR: The NISAR Prototype Airborne Instrument

Today

2022+

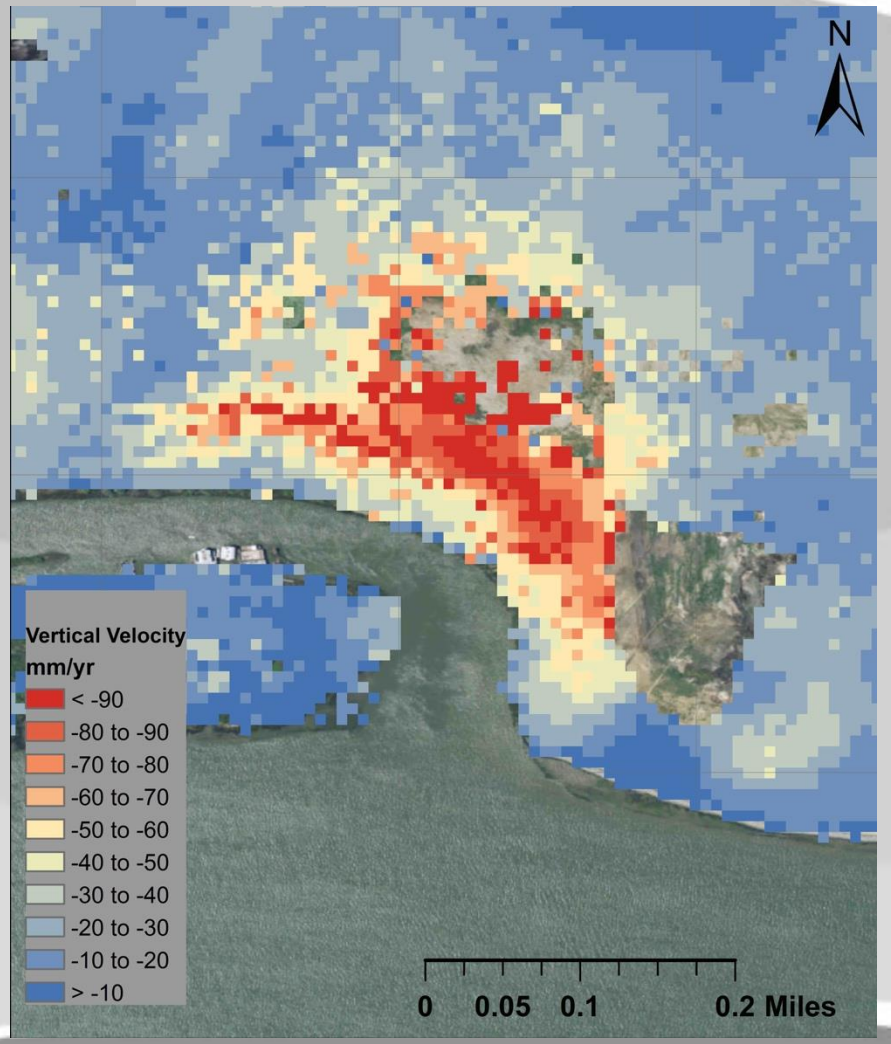


NISAR Launch Dec. 2021
Global coverage every 12 days

Subsidence & Levee Movement

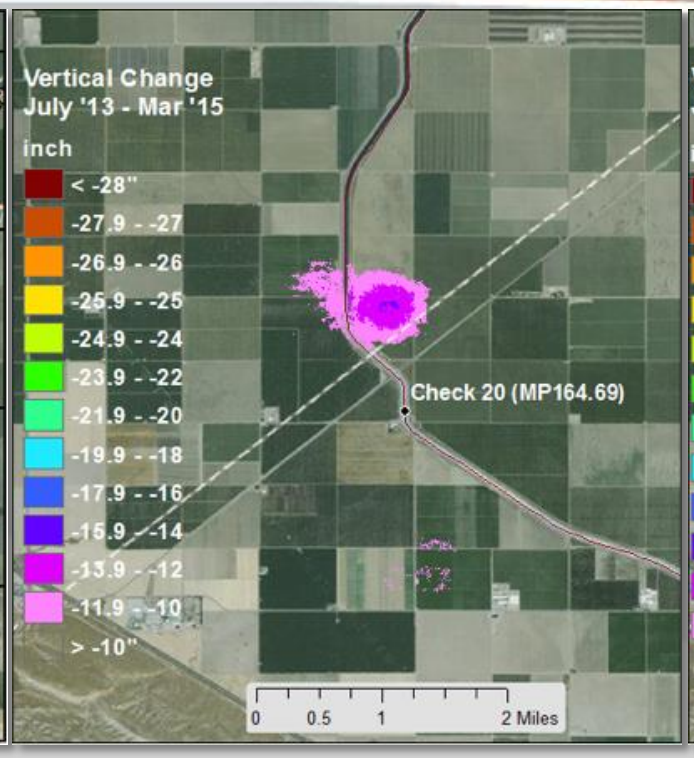
Subsidence & Levee Movement

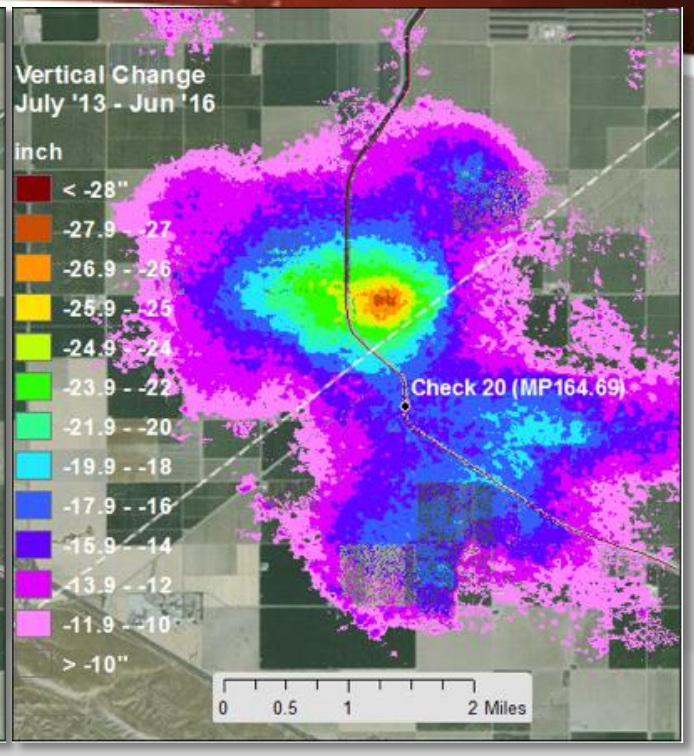
Vertical Velocity



Aqueduct Subsidence Monitoring

Avenal Hot Spot

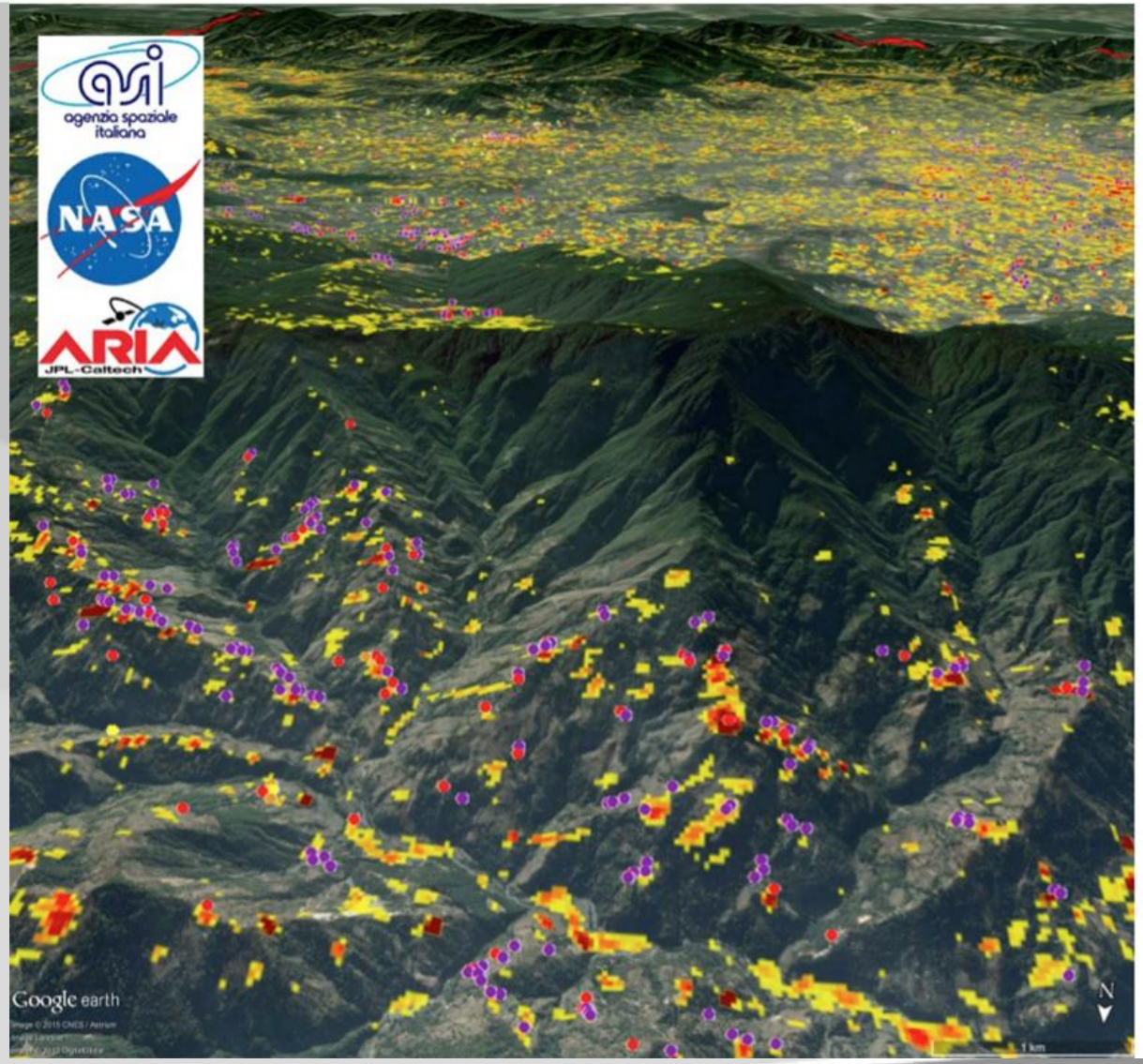


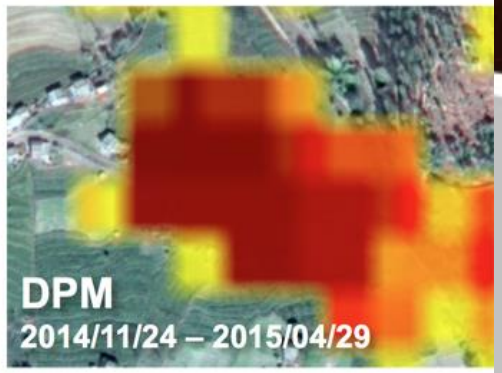


- Previously had seen 13” max subsidence of the aqueduct in July 2013 - March 2015.
- By June 2016 the same location showed 25” max subsidence of the aqueduct.
- 4.7 miles of the aqueduct subsided > 10”.
- InSAR averages over an area of ~25’x25’, so maximum at a point location is probably higher.
- DWR calculated that the aqueduct flow here is reduced by 20% from initial construction values, 8350 ft^3/s ---> 6650 ft^3/s.

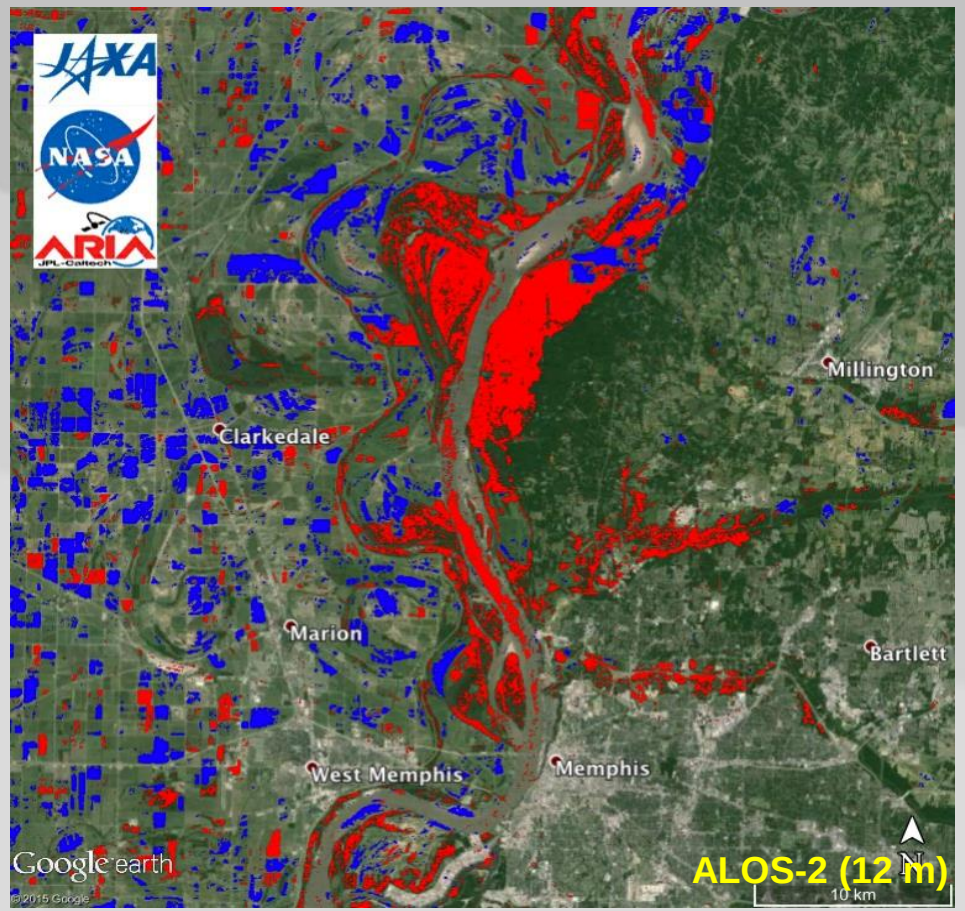
DAMAGE AND INUNDATION MAPPING

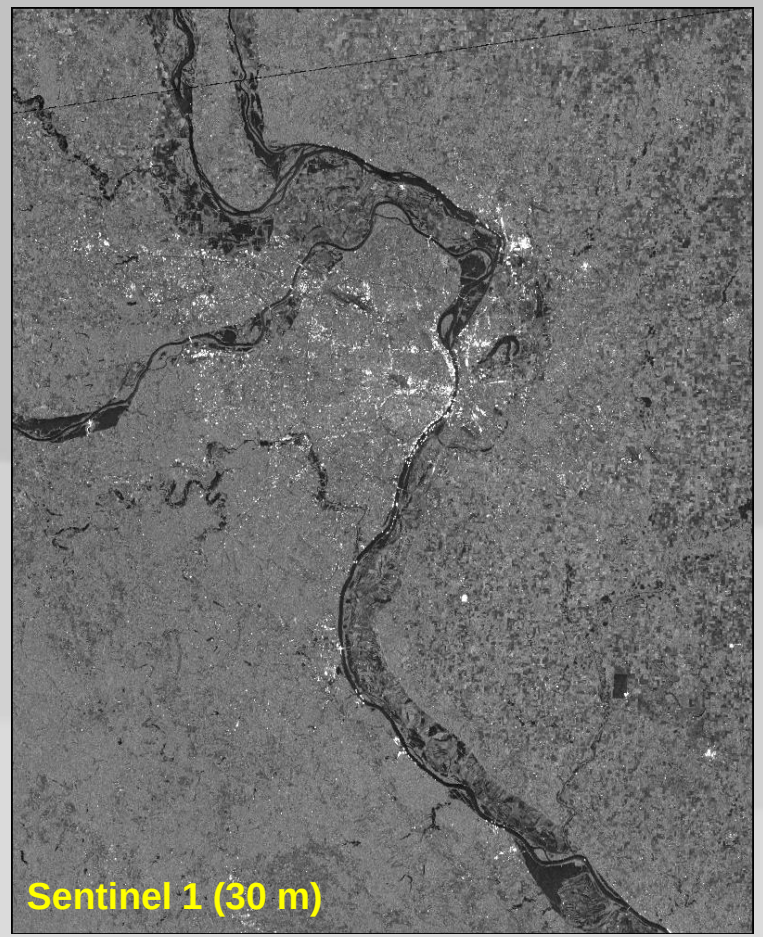
Damage Proxy Mapping

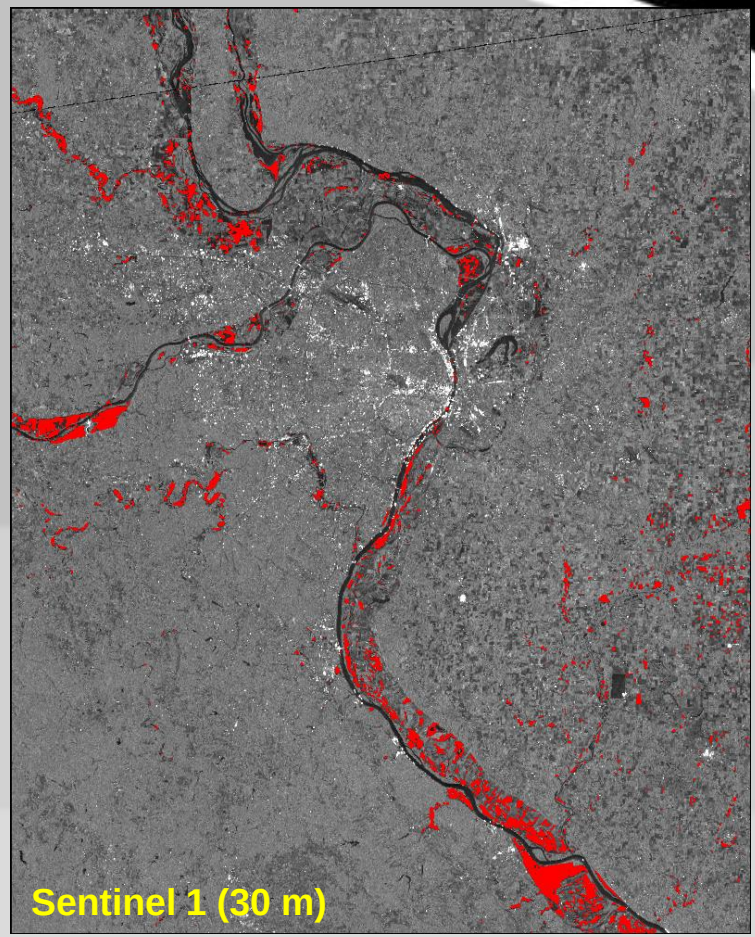




Inundation Mapping

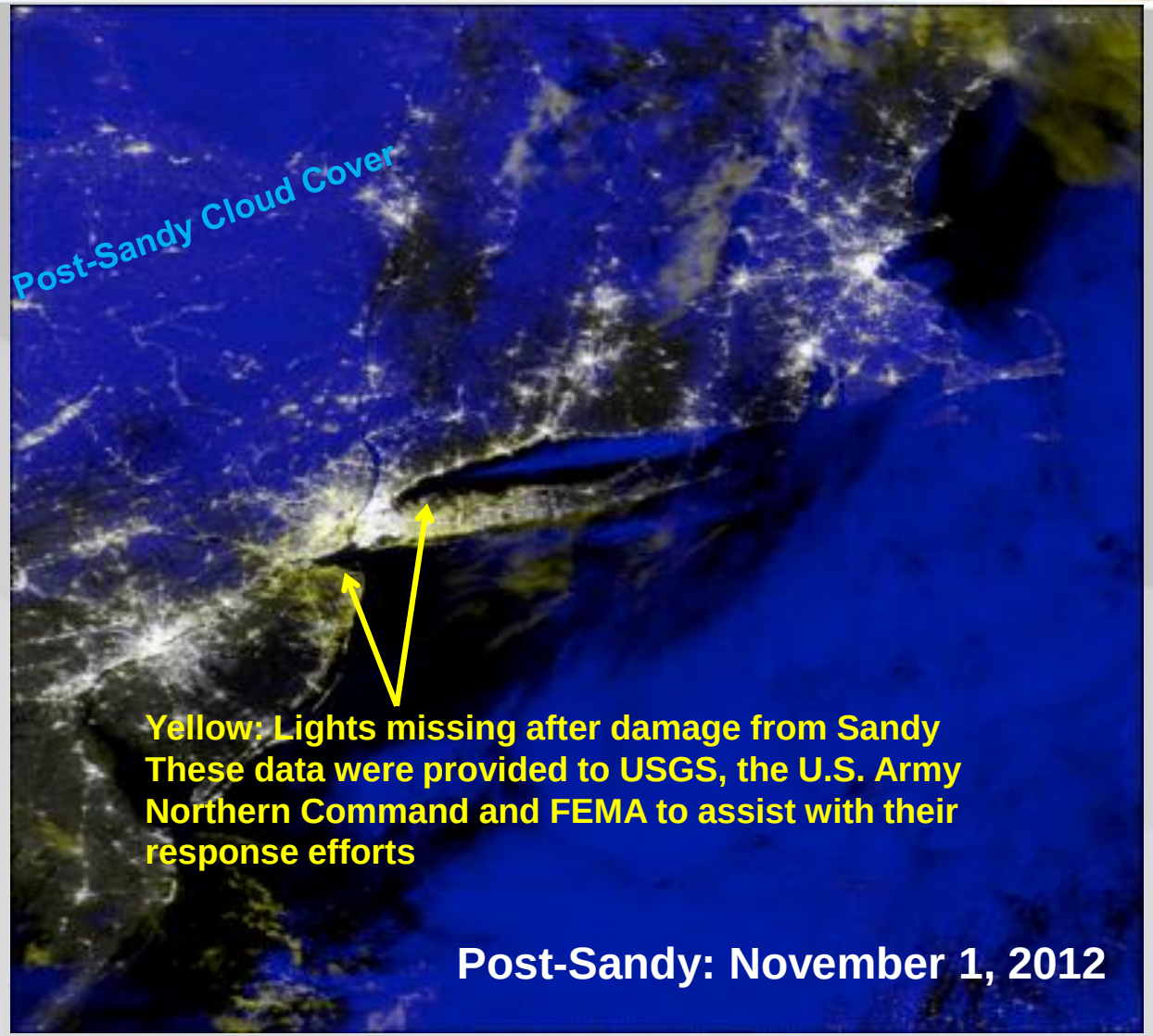




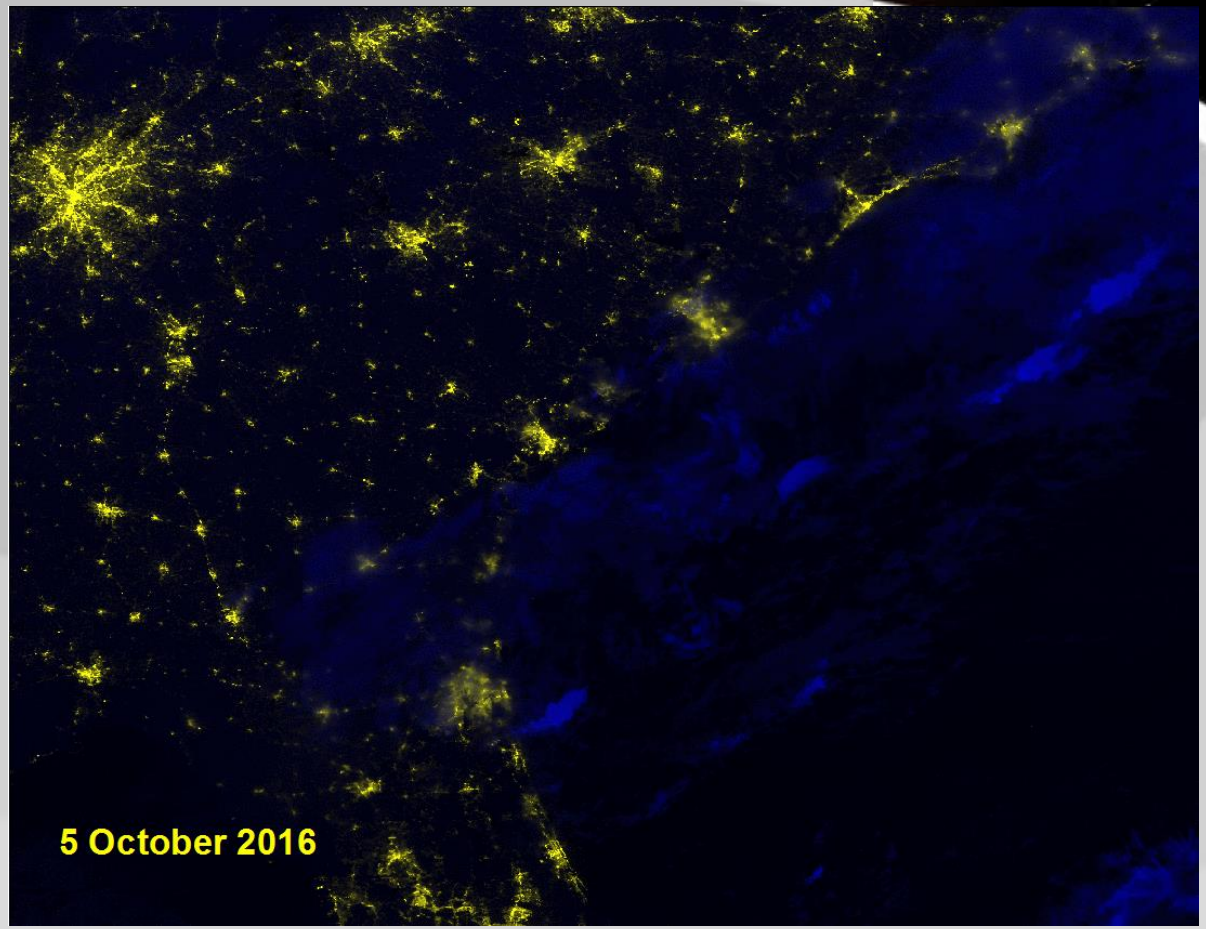


POWER OUTAGE ASSESSMENT

Power Outage Assessment



Hurricane Matthew



RISK EXPOSURE MAPPING

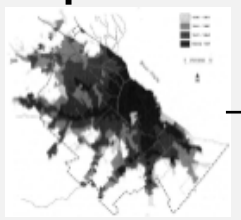
Thanks to: Charles Huyck and Ron Eguchi, ImageCat, Inc.

Risk Exposure Layers
Adding Context and Aiding Decision-making

Exposure Modeling

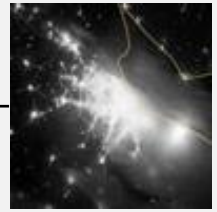
Default Exposure

Population

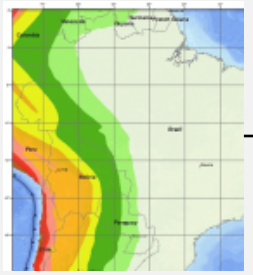


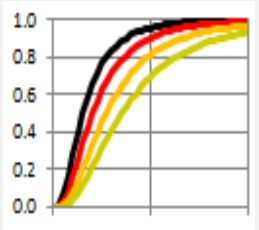
EO Exposure

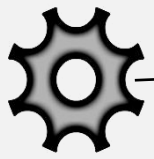
EO data

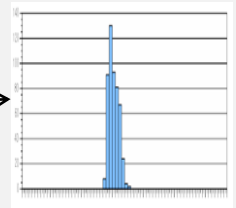


Loss Modeling









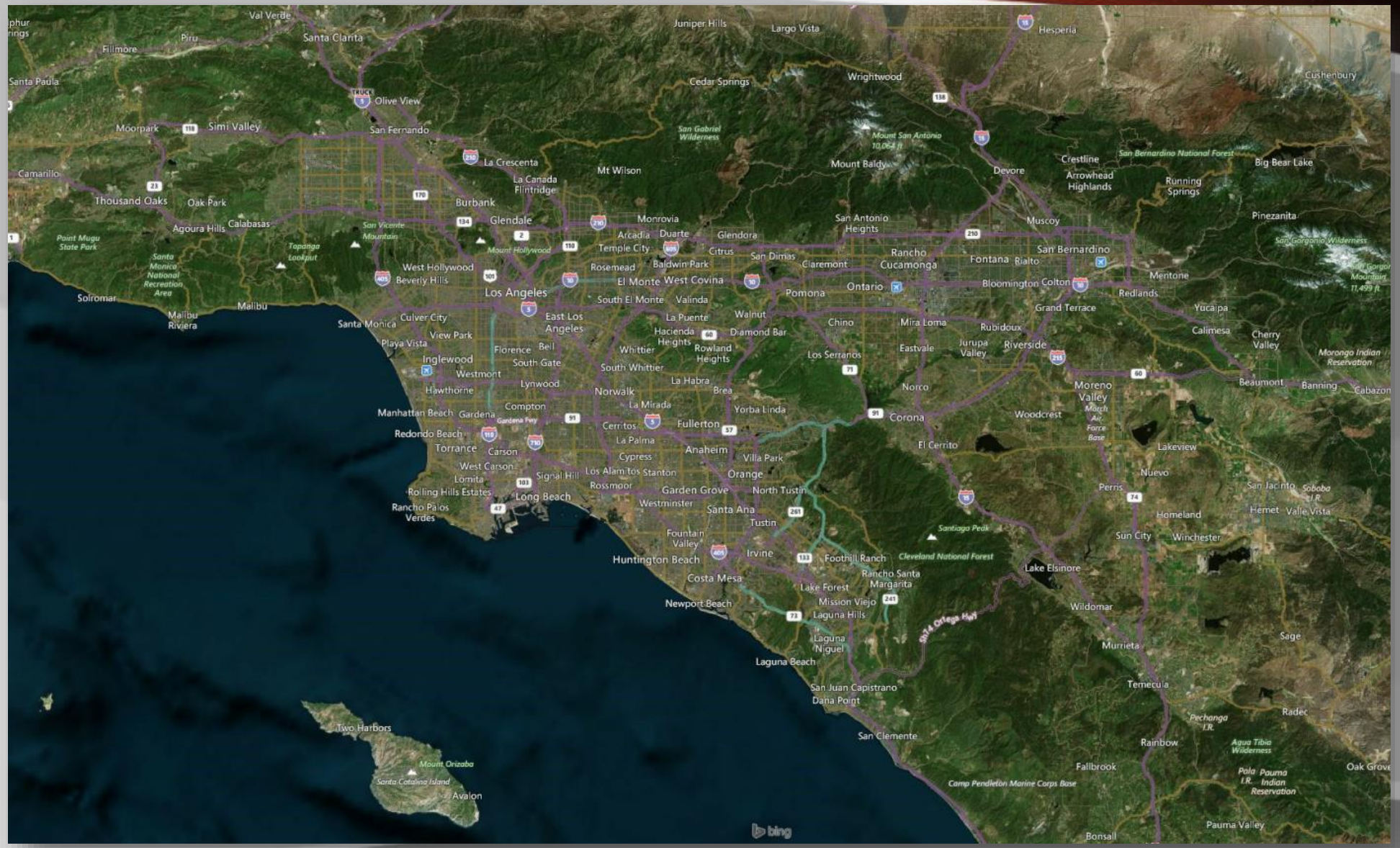
Hazard **Vulnerabilities** **Calculation** **Prob. Loss**

Developing Global Building Exposure for Disaster Forecasting, Mitigation and Response

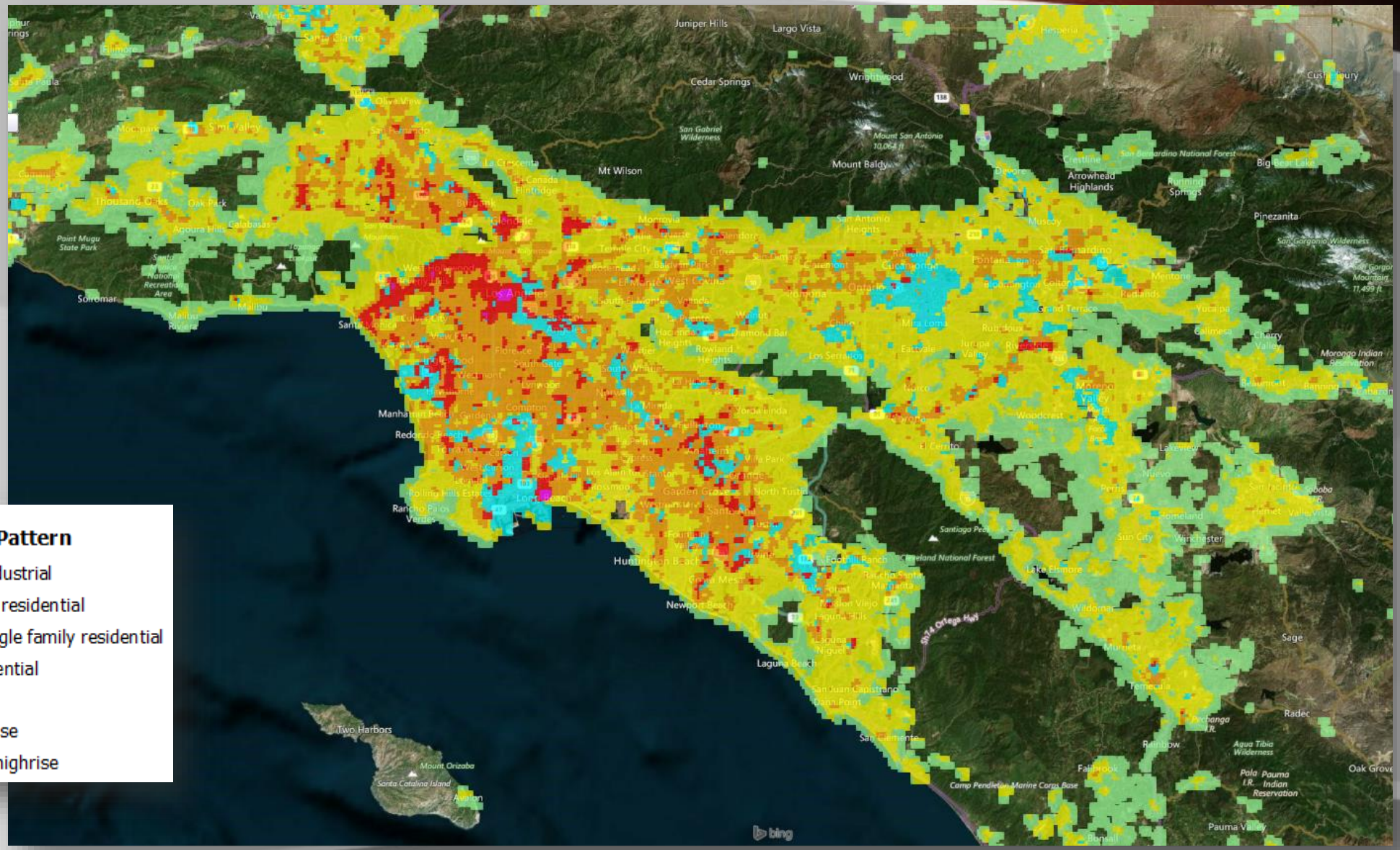
- Landuse or urban zone classification
- Population
- Structural characteristics
- **Building replacement values**

Decision Support

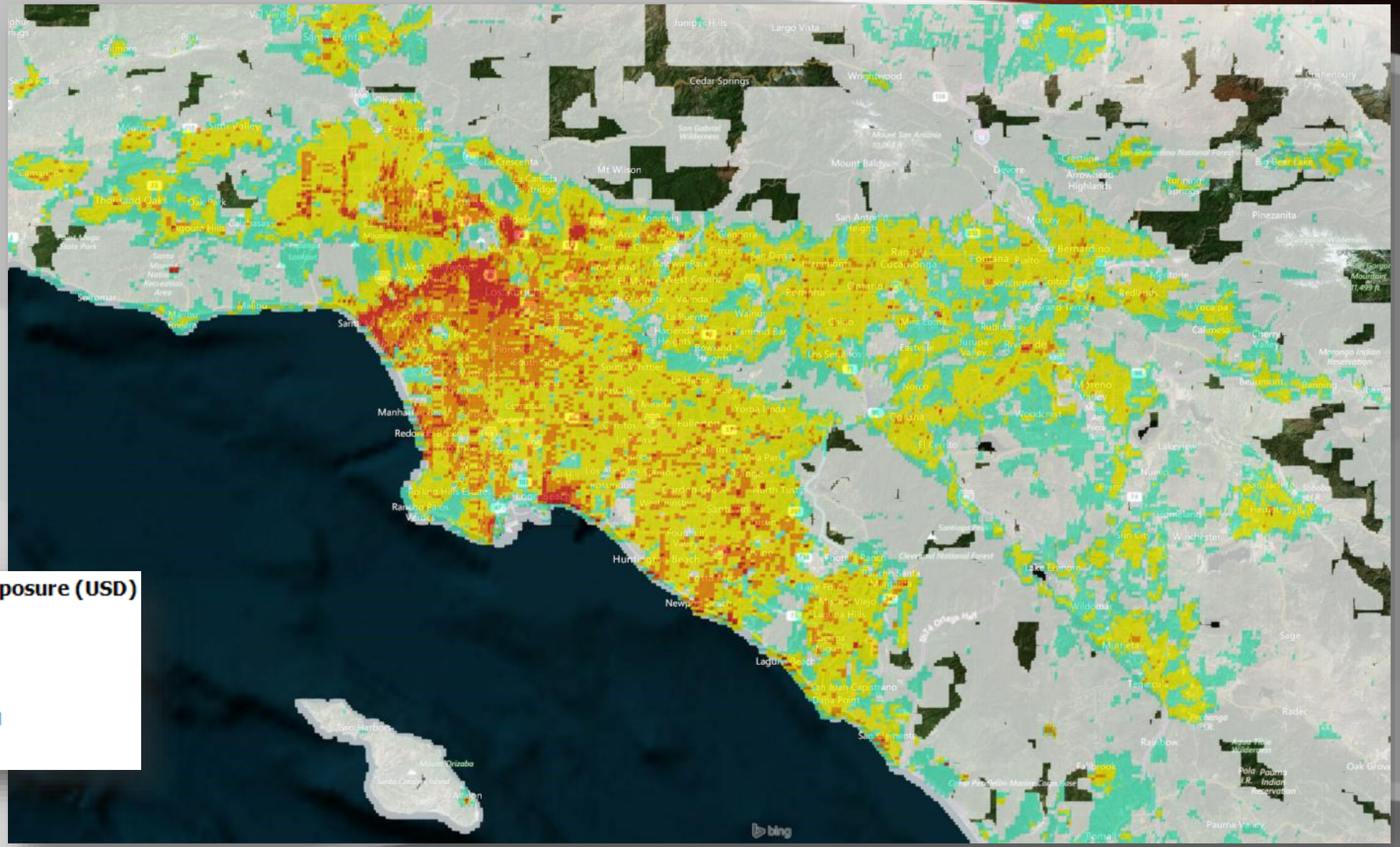
Los Angeles Basin



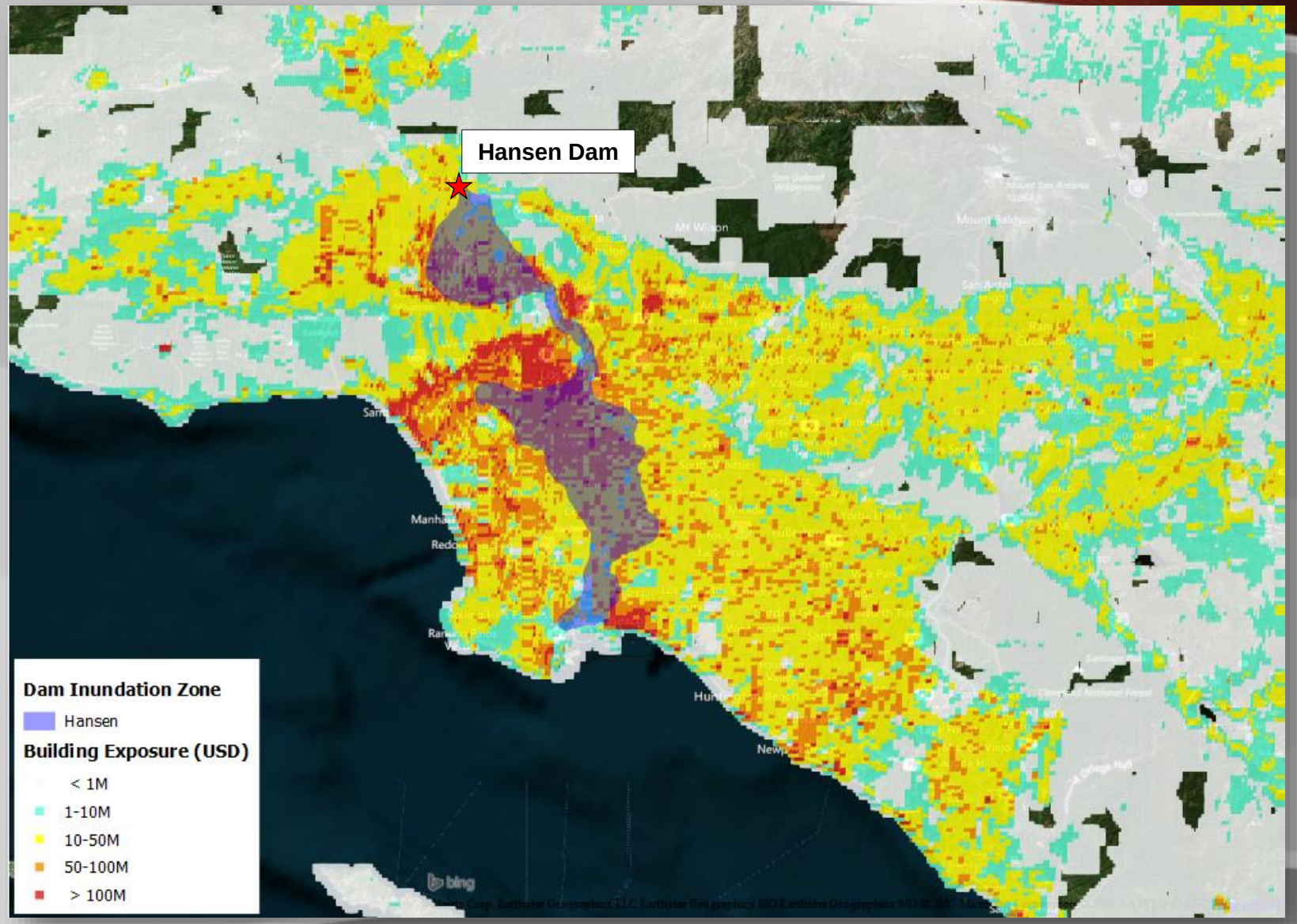
Development Pattern



Building Replacement Value



Hansen Dam Burst Inundation Area

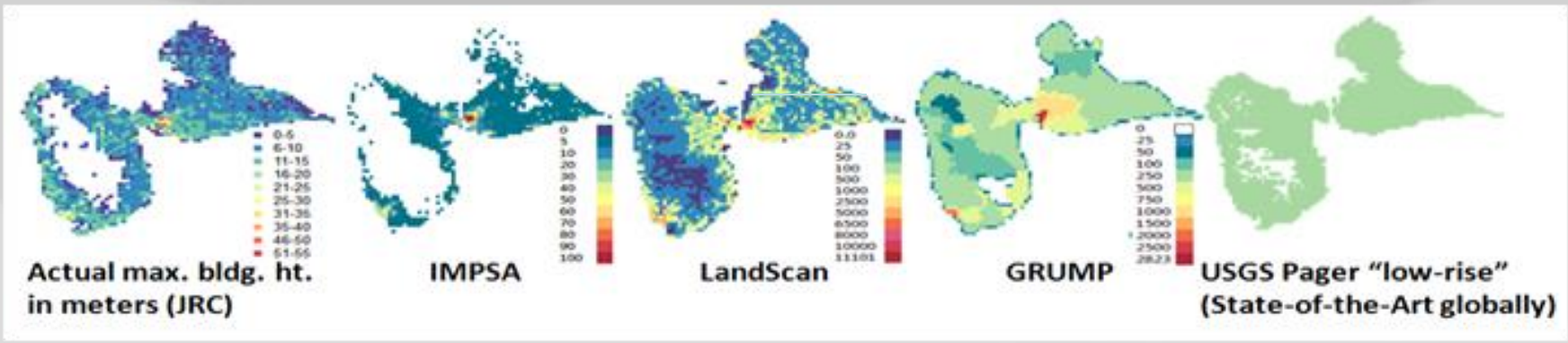


Exposure Affected by Hansen Dam

Occupancy	Total SQFT (Thousands)	Total Building Exposure ($Billions)
AGR	1,221	0.12
COM	186,786	26.09
EDU	8,467	1.27
GOV	4,777	0.57
IND	82,587	9.31
REL	9,011	1.50
RES	656,866	77.03
Grand Total	949,714	115.89

How do *Exposure Maps* enhance NASA's Earth Science Disasters Program

- Enhances situational awareness after a disaster – add exposure data layer to hazard data layer to estimate impacts
- Provides context for risk reduction and community resilience enhancement programs - benchmark current and future impacts for large regions
- Creates an entrée into commercial applications, e.g., insurance (especially in emerging countries and economies)



ARCGIS PORTAL DEVELOPMENT FOR DISASTER RESPONSE

NASA Disaster Applications Planned Architecture (Q3 2017)

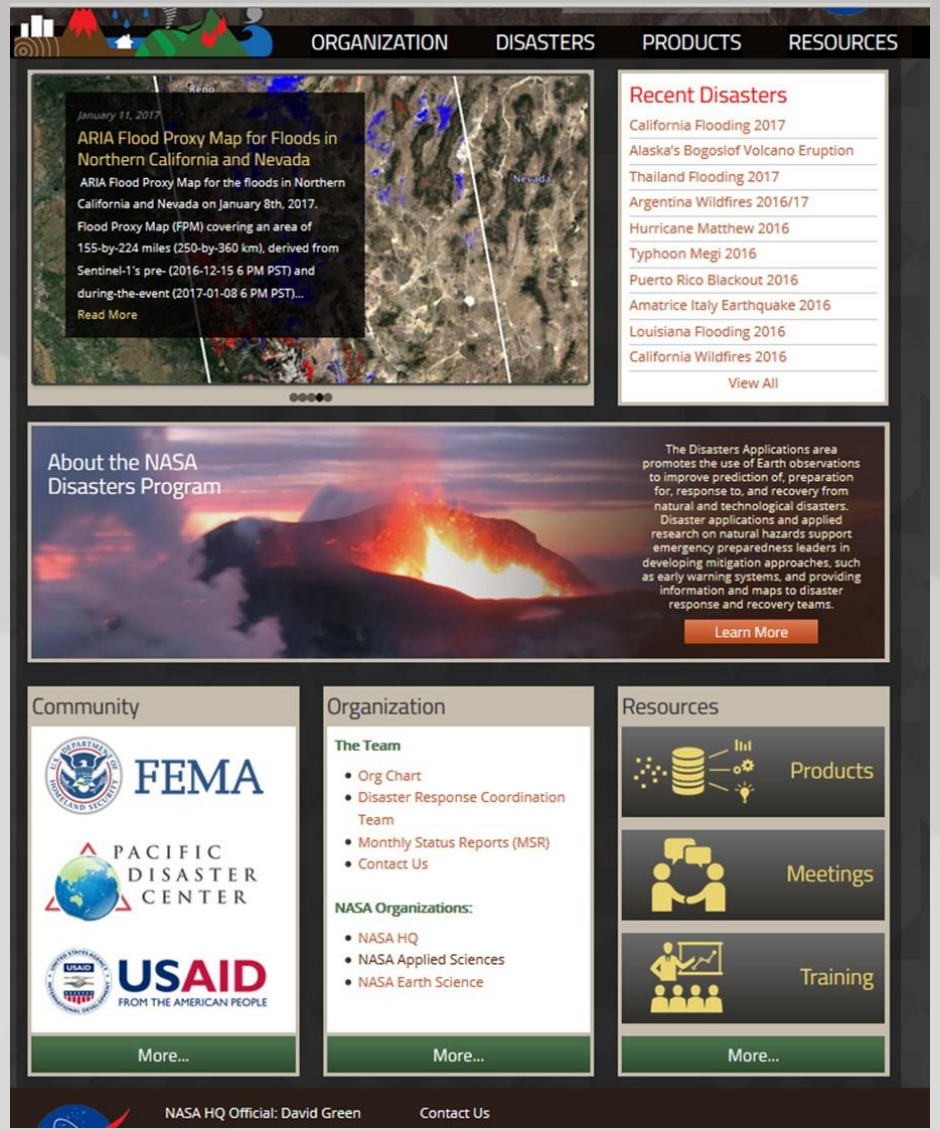
Satellites
Airborne
UAS
Partnerships

Tsunamis
Wildfires
Earthquakes
Severe Weather
Volcanoes
Tornados
Floods
Hurricanes
Oil Spills
Dam Threats

FTPs
APIs

NASA Disaster Applications GeoPlatform

GIS Apps & Systems



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Response: **https://disasters.nasa.gov/**

Program: **http://appliedsciences.nasa.gov/programs/disasters-program**